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DoD's WAR ON HAZARDOUS WASTE

Volume 2: An Indexing System for Measuring Hazardous Waste Reduction

Report PL907R3

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PREFACE

This is the Logistics Management Institute's (LMI's) second report on DoD's approach to hazardous waste reductions. In *DoD's War on Hazardous Waste: Measuring Hazardous Waste Reductions* (LMI Report PL907R2), we reviewed the waste and workload records at a single large industrial generator of hazardous waste. We concluded in that report that, with certain procedural modifications, the data required for DoD-wide measurement of hazardous waste were already being provided to the OSD level. We also found that the data for a single installation can be so dominated by anomalous events that year-to-year waste comparisons may be inappropriate. In this second report, therefore, we investigate the results of aggregating hazardous waste data from all DoD depots.

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LMI

Executive Summary

DoD's WAR ON HAZARDOUS WASTE

Volume 2: An Indexing System for Measuring Hazardous Waste Reduction

Federal and state authorities and the Department of Defense leadership have put DoD under continuous pressure to reduce its output of hazardous wastes – primarily the byproducts of essential industrial facilities, such as ammunition plants, research laboratories, and maintenance depots. Three years ago, the Joint Logistics Commanders, leading DoD's response to that pressure, committed the Services to cut in half by 1992 the amount of hazardous waste generated at their maintenance depots in 1985.

In an earlier study on DoD's war on hazardous waste, we investigated measurement at a single depot. In this task, we consider the use of available data to formulate a management indicator for use at all levels of DoD.

Although the DoD Components are making a substantial effort to meet the Joint Logistics Commanders' 50 percent reduction goal, we find that OSD does not have the information needed to monitor their progress, for the following reasons:

- The 1985 hazardous waste data are either not available or inaccurate, so DoD has difficulty establishing a baseline.
- Since DoD has no standard measure (e.g., volume, weight, toxicity, or disposal costs) of hazardous waste, aggregation of data from DoD Components is restricted.
- The extent of industrial activity at maintenance depots has decreased since the Joint Logistics Commanders' commitment; thus, any apparent reduction in waste generation must be tempered by lower production levels.
- Because Federal and state governments continue to change the definition of hazardous waste, year-to-year comparisons are often meaningless.

To overcome those shortcomings, we recommend that the Deputy Assistant Secretary of Defense (Environment) [DASD(E)] take the following actions:

- *Direct the DoD Components to measure and report all hazardous waste data in kilograms.* Since Federal laws permit hazardous waste data to be provided to regulatory agencies in kilograms, DoD should use that same measure.

- *Require DoD Components to report all treatment and disposals of hazardous waste, and define those terms to prevent confusion over what is to be reported.* DoD's primary problem with hazardous waste is the need to remove it for treatment or disposal. While OSD should adopt a common approach to defining other processes (such as generation, storage, and recycling), the OSD data collection effort should focus on the most significant problem.

- *Investigate and determine how to measure the risks and costs associated with hazardous waste.* Current methods for measuring hazardous waste do not address the environmental risks and costs of disposal, which are the primary reasons for reducing hazardous waste. Those methods need to be improved.

- *Use an indexing method and readily available data to relate waste generated to industrial production levels. Initially, the index should be kilograms of waste per direct-labor hour.* Merely knowing the amount of hazardous waste that is disposed during a given time period is not enough for DoD leadership to fully comprehend and support continuing waste-reduction initiatives. Annual data on hazardous waste disposal are complicated by changes in operating tempo at the depots; those changes are, in turn, driven by a range of factors, such as budget cuts, force reductions, combat deployments, etc. The Office of the DASD(E) [ODASD(E)] is interested in separating out the true waste reduction achieved by better management from that achieved by other means; thus, the level of industrial production that resulted in the waste must be considered.

- *Build upon DoD Components efforts to date to develop DoD-wide definitions of categories of industrial processes that are tied to the generation of different types of hazardous waste.* Regulations and statutes change frequently, with significant effects on definitions – and hence on output quantities – of hazardous waste. To manage and account for such changes, both the Army and Navy collect waste data using categories of industrial processes. The same management information is needed DoD-wide.

- *Include data fields in the Defense Environmental Management Information System to assess the regulatory climate faced by DoD activities.* In addition to technical process issues, a particular area of concern is the unilateral adoption of stricter environmental standards by states than are adopted by

the Federal Government; OSD needs to have an insight into the effect of such activities on reduction efforts.

We believe that by taking the actions we recommend, DoD will be in a position to monitor both current hazardous waste production levels and its progress toward reducing those levels. The same monitoring system and calculations can be used at the OSD and all subordinate levels – Service staff, major command, and depot command management – to review progress in hazardous waste reduction and to identify areas in which additional emphasis is required. With that information, DoD can take constructive action toward becoming a national leader in hazardous waste management and reduction.

CONTENTS

CONTENTS (Continued)

TABLES

FIGURES

CHAPTER 1

THE ENVIRONMENTAL CHALLENGE

Industrial processes create products that are not found in nature, and thus some disruption of nature is unavoidable. At one end of the spectrum, that disruption may take the form of less aesthetic surroundings; further on, it may have adverse effects on plant and animal life; and at the other end, it may be a risk to human health. Environmental laws have two basic objectives: to protect human health and to protect the natural world around us. As a rule, complying with those laws is expensive. The challenge for all major industries is to continue their productive activities (which are also beneficial to society) in an economically viable way while remaining in compliance with Federal, state, and local laws.

Although complying with environmental laws can be expensive, failure to comply can quickly become *prohibitively* expensive. Hazardous waste is regulated with increasing intensity. The labor and financial costs of monitoring, accounting for, and disposing of hazardous wastes are very high; even when the waste has been properly transferred to an authorized agent, the original user's liability never expires. A precedent now exists for imposing criminal liability on Federal employees for inattention to environmental requirements. In short, hazardous waste is an expensive and personally risky business. While DoD's operational requirements may make it impossible to get out of that business altogether, we see compelling arguments for DoD's trying to reduce its exposure to both the costs and risks as much as possible.

Recognizing these imperatives, the Joint Logistics Commanders (JLC) announced in 1987 that DoD maintenance depots would embark on programs that would attempt to reduce the total output of hazardous waste to half the amount generated in FY85. Their goal was to achieve that reduction by FY92. Since that time, the DoD Components have initiated hazardous waste reduction programs at

their maintenance depots. Some progress has been made, but a quantitative assessment of that progress is complicated by two major issues:

- Should "output" include all the waste generated or only the wastes disposed of off installation? This issue was ostensibly resolved when the JLC decided that the announced goal would address the generation of waste, not merely its disposal. However, data collection systems were not always modified in response to that decision, and in those cases only disposal data were recorded.
- Can DoD credibly claim success in reducing waste between 1988 and 1992 considering that a significant reduction in depot maintenance activity is expected over the same period?[1]

The Logistics Management Institute (LMI) was asked by the Office of the Assistant Secretary of Defense (Environment) [ODASD(E)] to address these issues and answer the following questions without recommending the imposition of a new reporting burden.

- Can hazardous waste levels be adjusted for a changing operating tempo?
- Can such adjustments be applied retroactively to determine DoD progress against the original FY85 generation level?
- Can the resulting adjusted data or index, as we call it in this report, be useful as a management tool for OSD and Service staff monitoring of DoD progress in controlling hazardous waste?

In an earlier report,[2] we considered whether any data existed to make a hazardous waste measurement and indexing system possible without an excessive burden on the installations. That report identified data sources and noted some significant challenges posed in the data obtained. This report considers the effectiveness of the index using data from all depots.

During the course of this study, we visited Letterkenny Army Depot, Chambersburg, Pa.; Portsmouth (N.H.) Naval Shipyard; the Marine Corps Logistics Base, Barstow, Calif.; Sacramento Air Logistics Center; the Sacramento Army Depot; and several facilities at the Navy's complex of installations in the Hampton Roads,

[1]Note, for instance, *Phantom Reductions: Tracking Toxic Trends*, Gerald V. Poge and Daniel M. Horowitz, National Wildlife Federation, Washington, DC, 1990, in which many "waste reductions" claimed by major industries are discarded as being due to disingenuous accounting.

[2]LMI Report PL907R2, *DoD's War on Hazardous Waste: Measuring Hazardous Waste Reductions*. Douglas M. Brown and Paul F. Dienemann. January 1991.

Va., area. At those sites, we validated the data available from OSD reports and obtained many useful insights into the problems with current reporting procedures and into a number of proposed solutions.

In Chapter 2, we review the sources from which measurements of hazardous waste and appropriate adjustment factors may be derived and the construction of an index. In Chapter 3, we demonstrate the index using the depot's data, and identify some limitations to the basic index. In Chapter 4, we explore the data in more detail to provide the index with greater power as a management tool, and in Chapter 5, we lay out the use of such a tool. Chapter 6 summarizes our conclusions and recommendations and provides an implementation plan.

CHAPTER 2

DEFINING A HAZARDOUS WASTE INDEX

INDEX CONCEPTS

The preferred indexing system would be one that poses no new reporting burden on installations and the Military Services (i.e., one that uses existing data). To avoid conceptual confusion, the index should be simple in presentation, such as a number or a ratio with units of measurement, rather than an artificially contrived composite index. The index must not require that OSD or Military Service headquarters micromanage installation-level affairs; yet it should have value for DoD managers at all levels.

One approach to tracking a byproduct from an industrial facility is to relate the amount of byproduct generated to the level of activity at the facility. Indices are very effective in establishing that type of relationship. An index is computed by dividing an output by an input to create a normalized performance indicator. In the case of an output (waste) produced by the input (workload) of our industrial facility, this relationship is simply expressed as:

$$Index = \frac{Waste}{Workload}$$

This indicator, or index, shows the relative amount of hazardous waste generated for every unit of work done by the facility.

While the general form of the index seems clear, the greater challenge is to select the units of measure to be applied while taking advantage of existing data sources.

In reacting to the ODASD(E)'s tasking, we found two data issues that warrant immediate attention. The first entails identifying readily available measures of hazardous waste that could be used in monitoring the Military Services' progress toward meeting the 50 percent reduction goal. The second involves various measures of workload, also readily available, that could serve as indicators of the level of

production required to generate the associated hazardous waste. In the balance of this chapter, we address these two issues in more detail.

WASTE MEASURES

The measure of the amount of the environmental pollution that we desire to reduce has traditionally been expressed in terms of volume or weight. Since we seek to reduce hazardous waste to lessen environmental risk and lower production costs, we considered more direct measures of risk and economy as well as the normal quantity-based measures.

Quantity-Based Measures

If the output of hazardous waste is to be based on quantities, we should make all our measurements on a common scale; we cannot, for example, mix kilograms and gallons of waste. Since all current environmental laws either require or allow hazardous waste data to be provided to regulatory agencies in kilograms, we recommend DoD use that measure for all waste issues.

Sources of Data

Waste data are collected at the OSD level. Before 1990, those data had been provided through the Defense Environmental Status Report (DESR); those data are generally considered unreliable because data collection in the reporting agencies has been poor and because imprecise definitions are used. Beginning in 1990, the DESR data will be replaced with the Defense Environmental Management Information System (DEMIS). While it provides a much clearer definition of the reporting requirement, its effectiveness has not been tested since the first round of data has yet to be submitted. Unlike DESR, DEMIS is not configured to track the complete spectrum of waste activity – generation, storage, disposal, treatment, and recycling. DEMIS tracks only disposals.

Much of DoD's hazardous waste disposal is done by the Defense Reutilization and Marketing Service (DRMS). DRMS believes that its waste disposal data since October 1988 are accurate but considers earlier data to be unreliable. In addition, information on the amount of waste disposed of by installations through local recycling or treatment facilities without DRMS involvement would require additional data to be submitted by installations.

The Environmental Protection Agency (EPA) is another source of data on hazardous waste. It requires all hazardous waste generators, including Federal agencies, to report disposal data either directly or through delegated state agencies. However, those data are not reported annually but rather every 2 years. Furthermore, EPA program offices do not consider data prior to 1988 to have been effectively reported by the generating facilities, again including Federal agencies.

All the data have limitations. In many cases, the weight data are not accurate because installation environmental staffs do not have time to weigh each drum of substance shipped out, because some substances are shipped in bulk by volume with no real idea of the weight of the substance itself, or because some substances are irretrievably commingled with water on their way to a treatment facility. In the past, waste generation data were not tracked by all facilities, but under regulatory pressures, all facilities now make efforts in that direction. Thus, although generation figures could be used in the future, we have to use waste disposal data to reconstruct progress to date.

Disposal Versus Generation

The appropriateness of using generation or disposal data as the basic measurement standard for monitoring hazardous waste is under dispute. We cannot clearly ascertain which data – generation or disposal – make up the historical figures. Some have argued that maintenance depots should be credited for waste that is treated or recycled as part of the postproduction process. Others say that as long as waste is stored at a depot, it poses health risks and is a liability to DoD in the event of mishandling; thus, they argue, DoD should also encourage the elimination of that form of waste. Clearly, the availability of a large storage facility allows large quantities of waste to be ignored until the time comes to dispose of them.

Although the JLC specified waste generation in their original goal, the staffs at several depots have pointed out that the rigidity of the current military specification and technical order system make prompt elimination of hazardous products difficult; thus, significant efforts have been expended in devising means of neutralizing or recycling hazardous wastes. To ignore a possibly large difference between the generation of such waste and its disposal fails to give credit to those installations that have done what they can within the existing system to reduce the imposition of hazardous materials on the environment.

For those reasons, the Military Services have elected to collect data that reflect not only hazardous waste disposal but also its generation, treatment, recycling, and storage. ODASD(E) should exercise its leadership role in facilitating a common understanding and definition of those terms. However, OSD must maintain a more global perspective, and its true objective is to minimize the adverse impact that DoD facilities have on the environment. Thus, it must concentrate its primary interest on determining the amount of hazardous waste that must be treated or disposed of. One might add that priority should be given to the treatment or disposal of hazardous waste that must take place off the installation since those activities expose the public to a greater risk than do on-base treatment or disposal; however, few maintenance depots have such facilities on base.

Process or management changes leading to significant reductions in disposal or treatment will in turn reduce hazardous waste and will lower DoD's index. If it reaches a point that many depots are able to generate very low volumes of hazardous waste while handling large volumes of toxic material, it may be worthwhile to address the generation or recycling issues. For the present, however, such a situation is unlikely to occur soon.

Perhaps most important, by using disposal data rather than the generation data, DoD will be able to take advantage of historical data, which are not available for generation.

Lack of Environmental Focus

Weight-based measures miss some key aspects of the hazardous waste problem. The components of the overall weight of waste vary from year to year with no corresponding changes in the weight of the wastes. In a given year, the waste from a certain maintenance workshop may be largely oily rags; in another year, it may be used hydraulic fluid. More important, efforts to reduce the amount of highly toxic waste produced often cause a net increase in the total volume of waste produced even though the resulting substances constitute less of a risk. An example of this dichotomy is the replacement of chemical paint strippers with nonhazardous abrasive materials. Finally, the reduction of weight may be completely unrelated to reductions in the output of toxic substances; for instance, compressing industrial waste sludge reduces the weight of water produced, not the amount of heavy metals.

Weight and volume, then, by themselves, are simple but not complete indicators. In addition to limitations in the collection of the data, both measures suffer from conceptual weaknesses in defining the "amount" of hazardous waste produced. Most important, they ignore the real purpose of hazardous waste reduction programs: to reduce risks or costs.

Alternative Measures

The volume and weight of material have an environmental impact in that those materials must be stored or disposed of. However, in terms of our overall environmental goals – reducing human health risks and ecological impacts while continuing to perform operational missions – volume and weight are not totally satisfactory indicators. A toxicity-based measure (i.e., one that measures risk) would preclude arguments over the relative concentrations of toxics in, for example, waste water or in sludge cakes. It would focus attention on the actual substance being produced and the environmental risks imposed by those substances, issues that form the core of the environmental program. Risk assessment as a science, however, has not been widely standardized, and further research is needed to develop risk-estimating algorithms that could be applied consistently at all installations without an unreasonable burden on the local staff. Since the EPA is still formulating its position on using a risk-based measurement system, DoD would not be addressing its problem in the accepted currency although it would be making an early start and could achieve recognition for its leadership in this field.

In many analyses, cost is often found to be a good surrogate for intangibles such as risk or toxicity. Disposal costs could be used as an alternative to risk assessment. In addition, one goal of the reduction program is to reduce the cost of hazardous waste disposal. Disposal costs are important in the hazardous waste reduction program because we must be careful that we do not spend more money to reduce a waste stream than it would have cost to dispose of it, especially when a more cost-effective project might have been carried out. Using DRMS historical data, we can certainly establish disposal costs for many classes of waste. DRMS, however, does not handle all wastes; thus, significant waste is generated but not recorded in the DRMS database. In addition, many products are handled by recycling, treatment, and storage. A cost-based measure displayed together with a risk-based measure would be particularly valuable because many highly toxic substances, such as arsenic, are easily neutralized and are inexpensive to dispose of, while other, more benign

substances incur charges for landfills certified to meet Resources Conservation and Recovery Act (RCRA) standards and are quite expensive to dispose of.

Finally, the unit costs of hazardous waste disposal have increased sharply in the past 5 years. As a result, DoD's costs to dispose of hazardous waste have increased even at those installations at which significant waste reductions have occurred.

Again, we recommend continuing investigation of the disposal cost approach, fleshing out the data sources and making some comparisons of a cost-based approach with other approaches prior to adopting that method as part of a set of three complementary measures of waste.

Conclusions

Weight is an imperfect measure of hazardous waste. It does not directly address the key environmental issues and it is subject to error in its own right. Nonetheless, we have no effective alternative measure at present. In addition, installation staffs are experienced in accounting for hazardous waste by weight, weight is used as a measure of hazardous emissions in all media programs (not just hazardous waste), weight is the basis for transportation manifests, and weight can be estimated when total control of every container is infeasible. None of these advantages accrue to the yet-undeveloped risk-based approaches. In short, we find that weight is the only reasonable way to address waste outputs at this time.

The question of what is to be weighed – disposal or generation – is less clear cut. We have little historical record of waste generation. Although Service waste-tracking systems are being developed, they will not be fully fielded for some time and initially we can expect inconsistent results from them. More important, to combine generation data with disposal data is to equate a potential environmental impact with an actual impact. Generated waste that can be neutralized, recycled, or otherwise rendered harmless or useful within the confines of the installation does not pose a significant management issue for DoD, particularly when DoD is faced with the management of millions of kilograms of disposed waste that is treated or disposed of at increasingly rare RCRA-permitted facilities at an ever-increasing cost. We find that the absence of historical data, the unreliability of future data, and the significant imperative to control disposals dictate that OSD focus its attention on the weight of treated and disposed waste. It should, however, define the other processes

and require Services to manage proposed data collection efforts within those definitions in order to endure consistency.

WORKLOAD MEASURES

Workload is a key factor in monitoring the progress made by the Military Services toward meeting the JLC's hazardous waste reduction goal. If hazardous waste levels decrease, DoD needs to be assured that the Service programs are working and it is not simply detecting a drop in the level of industrial production. The workload of a maintenance depot typically can be expressed in terms of the inputs required to carry out the maintenance function in a given period of time.

Within the JLC context, hazardous waste is generated through production activities at depots. If production processes were stopped or changed, waste would be reduced. Figure 2-1 shows a simplified maintenance depot in which an item of equipment to be repaired enters a maintenance process and, through the application of labor and materials, emerges as a repaired item, leaving some degree of waste as a byproduct. A first-level index can be constructed from any of the inputs (equipment, labor, or materials) shown in Figure 2-1. We call it the first-level index to indicate that a single set of aggregated numbers is required in its construction.

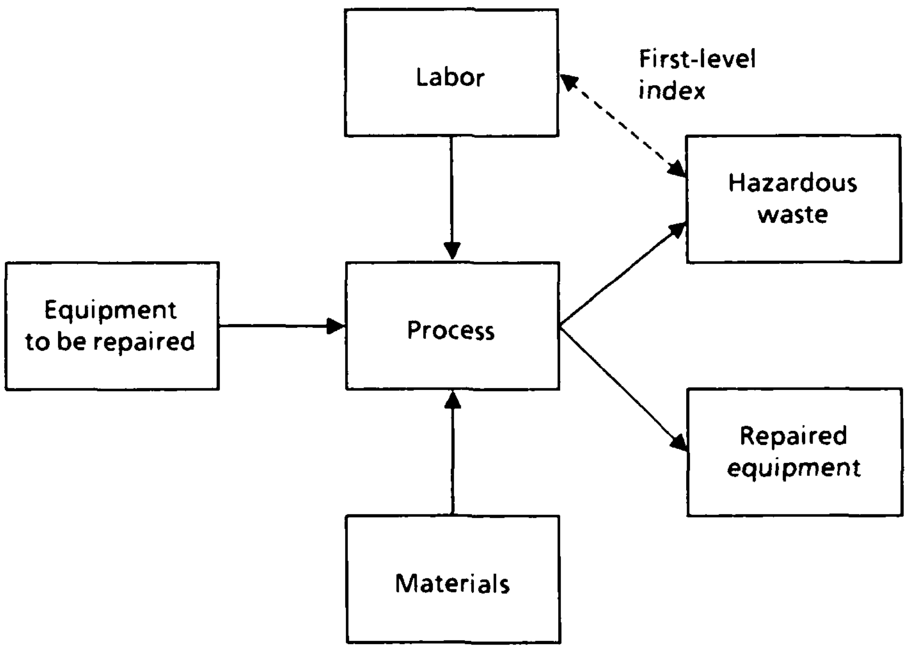

FIG. 2-1. GENERIC DEPOT MAINTENANCE PROCESS

Equipment To Be Repaired

Since the function of a maintenance depot is to repair equipment, one logical way in which to measure workload is in terms of the job to be done; i.e., the number of items to be repaired.

While such workload data are readily available, they are not easily aggregated. Obviously, an armored personnel carrier represents a significantly different workload, both in content and magnitude, than either a ship or an intercontinental missile, no matter what the operation to be performed. Even staying within the general class of "armored personnel carrier," we find that a variety of operations may be performed by a depot from year to year. It may completely overhaul (disassemble, repair, refurbish, and reassemble) the carrier; repair an engine; replace tracks; or install an equipment upgrade kit. Obviously, the nature of the work and, presumably, the associated waste generation differ widely among these processes. These variations do *not* even out over the course of a year as they might in the case of randomly arriving repair jobs at a commercial repair facility because depot work is often part of a major program involving thousands of items to be repaired in the same way in a year – and that work may be completely different from the work needed to support the major program in effect for the previous year at the same depot.

Additionally, it is common practice for an end item – a tank, for example – to be disassembled and its components repaired in different work centers within the depot or even at different facilities. At each point at which work is performed, the job is charged to the complete end item. Thus, one may find a record of work being done in many separate instances on a tank with no way of knowing that all that work is being done on the same tank. Such procedure invalidates any effort to compare work based on a single equipment count.

Another approach to equipment-based measurement would be to consider the costs of repairs assessed against each type of equipment. Those data are readily available and eliminate the problem of multiple counts of the same end item. That approach, however, would not eliminate the problem of wide discrepancies in the nature of the work performed; those discrepancies could be accompanied by equally wide but totally unrelated differences in cost. Finally, the costs include parts and materials that may require relatively little work; thus, cost is not necessarily a good indicator of the activities that occurred.

Labor

Another potential measure of workload (inputs) is the labor applied to the maintenance task. The total number of employees at each depot is easily cross-referenced in a number of places. However, the nature of the work at maintenance depots varies over time, and a recent General Accounting Office (GAO) report on hazardous waste indicates that depots have difficulty adjusting the size of their work force to reflect changing workloads.[1] Not all depot employees work directly in industrial activities, and not all those who work in those activities handle hazardous materials or generate hazardous waste. Thus, the total labor hours do not truly reflect workload.

Under the provisions of Department of Defense Directive (DoDD) 7220.29H, *Department of Defense Depot Maintenance and Maintenance Support Cost Accounting and Production Reporting Handbook*, each depot tracks the direct-labor hours applied to every job order. Those data have been collected since the early 1970s and are submitted annually through the Defense Manpower and Data Center to the Deputy Assistant Secretary of Defense (Logistics). While some discrepancies in accounting may exist, these "direct-charge" measures should generally describe the amount of work actually done.

Materials

Another possible measure of workload is the amount of materials consumed in effecting the repairs. In reviewing DoDD 7220.29H reports, we found that for most depots, material costs are highly correlated with direct-labor costs. Thus, this measure adds little value to the labor-hour measure. In addition, we noted earlier that reductions in hazardous waste risks may in fact be accompanied by an increase in the amount of materials consumed.

As an alternative to hour-based data, one could collect the costs of labor and materials, even combining them if desired. However, labor-hour and raw-materials costs differ in different years and different regions, and the incidence of cost increases is not uniform. Adjusting for inflation and regional cost differences adds significant complexities to the baseline data and annual calculation process as well as requiring even more data with which to perform the adjustments.

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[1]GAO NSID-89-35. *Hazardous Waste: DoD Efforts to Reduce Waste.* 1989.

Conclusions

The basic inputs to maintenance work are the equipment to be repaired, labor, and materials. The best recorded and most clearly related data are those summarizing direct-labor hours applied to maintenance tasks. Thus, we conclude that workload should be measured in terms of direct-labor hours.

TOTAL WASTE AND WORKLOAD

The JLC initiative encompasses only the maintenance depots. Although those installations generate a great deal of the DoD's hazardous waste, other installations are also significant producers of hazardous waste. The Navy's maintenance depots, for instance, account for only 50 percent of all Navy disposals.

Although the initial effort correctly focuses on the largest hazardous waste generators, to gain control of the entire hazardous waste problem DoD will have to address other installations once the measurement system is in place for maintenance depots.

CONCLUSIONS

The hazardous waste index should take the following form:

$$\textit{Hazardous waste index} = \frac{\textit{Hazardous waste treated or disposed of (kilograms)}}{\textit{Depot direct labor (hours)}}$$

We believe that DoD should use kilograms as the unit of weight and should measure the amount of hazardous waste disposed at and from its maintenance depots (to include both treatment and disposal). By using kilograms, DoD will comply with environmental laws and will be able to use the same data in its own reporting procedures and in compliance reports. The adjustments to the waste data to account for changed workload should be based on a measure of workload in direct-labor hours, thereby taking advantage of a relevant and accurate database that has been well established and is available at the OSD level today. The resulting index, then, would normalize DoD's output of hazardous waste in terms of kilograms of hazardous waste per direct-labor hour expended in the creation of that waste. Such a relationship has meaning at every level of DoD and should be applicable in concept to all DoD installations. In the following chapters, we show how such an index can be used.

CHAPTER 3

USING THE FIRST-LEVEL INDEX

In this chapter, we examine the first-level index in more detail and assess its value in monitoring the Military Services' progress in meeting the JLC goal of a 50 percent reduction of hazardous waste.

A HYPOTHETICAL EXAMPLE

A first-level index requires a minimal amount of data and detail in its construction. It can be readily understood as long as it accurately represents the underlying processes. Table 3-1 (containing hypothetical data) shows the potential index using such data (kilograms of hazardous waste per labor hour) for a 5-year period. We have used metric tons as units (a metric ton is 1,000 kilograms) to save space. Figure 3-1 portrays the same information graphically.

In each year, the index for each "depot" is calculated by dividing the waste by the workload (e.g., for Depot A in 1985, 1,200 ÷ 286 = 4.2). Additionally, the index for this hypothetical two-depot logistics command is calculated in the same way – waste divided by workload. Thus, for 1985, the total waste is (1,200 + 1,982 = 3,182 metric tons) and the total workload is (286 + 1,982 = 2,268 thousand direct-labor hours); the command index is (3,182 ÷ 2,268 = 1.4).

We have portrayed the net changes at the end of the 5-year period. Depot A has reduced its total output of waste by 50 percent, but its accomplishments are even more commendable than that, because it has done so while its workload increased by 75 percent. The real reduction in waste – in terms of kilograms per labor hour, is provided by the ratio of the indices for the years 1985 and 1990; moving from an index of 4.2 to an index of 1.2 represents a 71 percent reduction of waste when workload is included as a factor.

The point of indexing is highlighted by both of these hypothetical depots. Depot A made excellent progress in waste reductions, and the index gives it additional credit for its accomplishment in the face of increased workload. Depot B, on the other hand, would be pleased to report a decrease in hazardous waste of

TABLE 3-1

HAZARDOUS WASTE – HYPOTHETICAL

(Waste in metric tons; workload in thousands of hours)

	1985	1986	1987	1988	1989	1990	Net change, 1985 to 1990 (%)
Depot A							
Waste	1,200	1,400	1,108	910	803	600	- 50
Workload	286	400	369	364	472	500	+ 75
Index	4.2	3.5	3.0	2.5	1.7	1.2	- 71
Depot B							
Waste	1,982	1,748	1,610	1,540	1,150	1,253	- 37
Workload	1,982	1,345	1,463	2,200	1,437	1,139	- 43
Index	1.0	1.3	1.1	0.7	0.8	1.1	+ 10
Command total							
Waste	3,182	3,148	2,718	2,450	1,953	1,853	- 42
Workload	2,268	1,745	1,832	2,564	1,909	1,639	- 28
Index	1.40	1.80	1.48	0.96	1.0	1.13	- 27
(Incorrect) mean of A + B index	2.6	2.4	2.0	1.6	1.2	1.1	- 58

37 percent; this disingenuous reporting is unmasked by the index which shows that, in fact, after adjusting for the depot's greatly decreased workload, its hazardous waste output has really increased. Notice also that, in the case of Depot A for 1986, the index can decrease even in the face of an *increase* of hazardous waste output if the increase in workload is proportionately even greater.

Finally, we included the mean of the indices to highlight the inaccuracy of such an approach. Failing to weight the average – in other words, to sum the underlying data – does not result in a true mean; it is nothing more than what it says: the average of the averages. We can see that using those figures, the hypothetical command would be widely misled in assessing its performance. To calculate the overall index, we must know the total amounts of waste output and workload inputs.

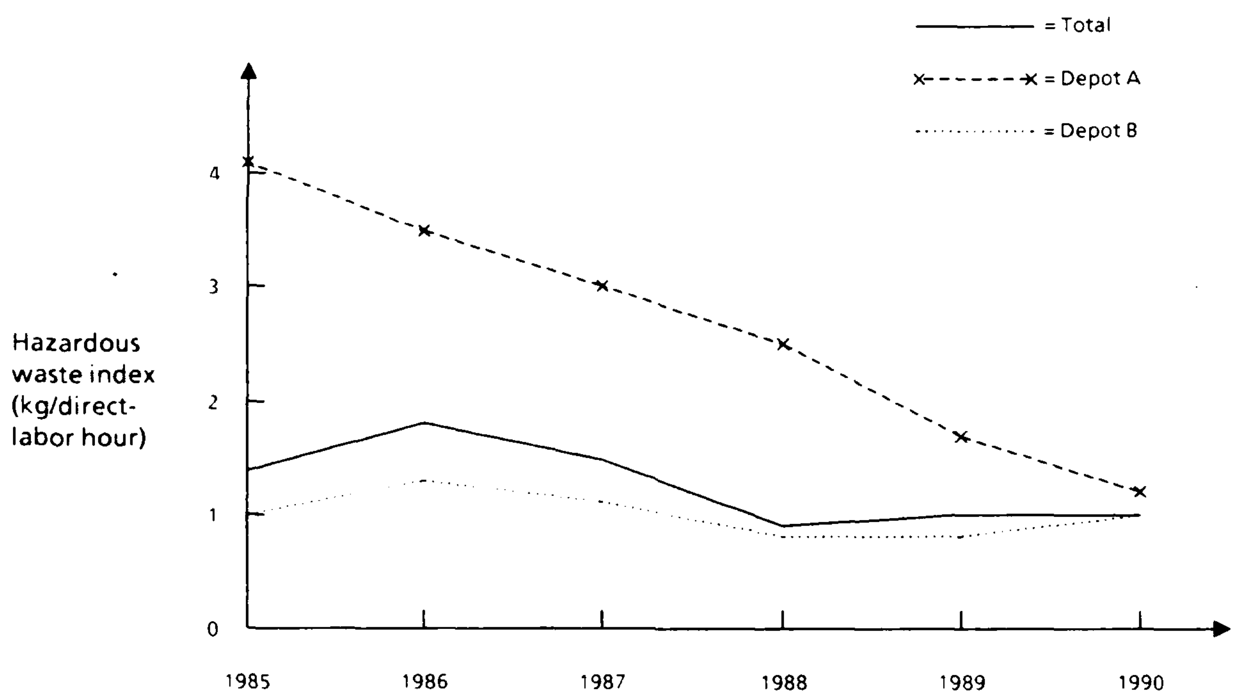


FIG. 3-1. PROGRESS OVER TIME
(Hypothetical data)

Figure 3-1 shows the ability of a logistics command to track installations' progress in waste reduction rapidly using the data from Table 3-1 in a graphical form. Depot A is clearly making substantial progress in reducing the amount of hazardous waste that it is generating, while Depot B has stabilized at approximately 1 kilogram per direct-labor hour. If the logistics command has only these two depots, then a composite first-level index (the total line in the figure) shows a favorable trend. Comparisons of indices at a given point in time is not appropriate; although Depot B's index in 1989 is only 0.8 while Depot A's index is 1.7, it would be unfair to praise Depot B (which is making no progress) and condemn Depot A (which has made significant progress). Even when tracking performance over time, comparisons between organizations must be done with caution. Since the total number of depots is quite small, serious statistical manipulation is impractical, and the workload varies widely among installations in terms of the type of equipment maintained and the type of work done. Tracking a single organization's progress by using its index over time is, however, entirely appropriate.

USING THE INDEX WITH REAL DATA

In a recent data call, ODASD(E) obtained information from each of the Military Service environmental staffs on hazardous waste disposed of by all maintenance depots. We combined that information with workload data and display the results in Table 3-2.

TABLE 3-2

HAZARDOUS WASTE DISPOSAL HISTORY

(Waste in metric tons; workload in thousands of labor hours)

DoD Component	1985	1986	1987	1988	1989	Percent reduction to date
Army						
Waste	63,932	78,261	60,996	28,648	30,951	52
Workload	22,594	23,726	22,151	22,398	17,207	24
Index	2.83	3.30	2.75	1.28	1.80	36
Air Force						
Waste	32,185	33,903	33,045	17,696	15,613	52
Workload	41,789	43,944	44,086	37,966	38,406	13
Index	0.77	0.77	0.75	0.47	0.41	46
Navy/Marine Corps						
Waste		–	27,676	29,265	23,134	17
Workload	–	–	76,542	82,270	69,799	9
Index	–	–	0.36	0.36	0.33	8
Total						
Waste	–	–	121,717	75,609	69,698	43
Workload	–	–	142,779	142,634	125,412	12
Index	–	–	0.85	0.53	0.56	35

The effort to track DoD's progress back to a 1985 baseline is hampered by the fact that only the Army and the Air Force have such data. However, the data we do have seem to suggest that DoD is making good progress toward a 50 percent reduction in its waste, even starting from 1987 levels, and may be able to achieve its goal by the original 1992 target. The data also indicate that the significant

reductions of waste have been accompanied by decreases in workload. These data appear to confirm the value of the index concept both as a top-level form of measurement and in the need for a workload-based adjustment.

Again, one of the values of the indexing system is that it allows us to represent a somewhat complex set of figures quickly in a visual form. Figure 3-2 shows the DoD data, and the lack of progress in 1988 and 1989 makes it quite clear that the significant reductions in those years were accompanied by equally large reductions in workload.

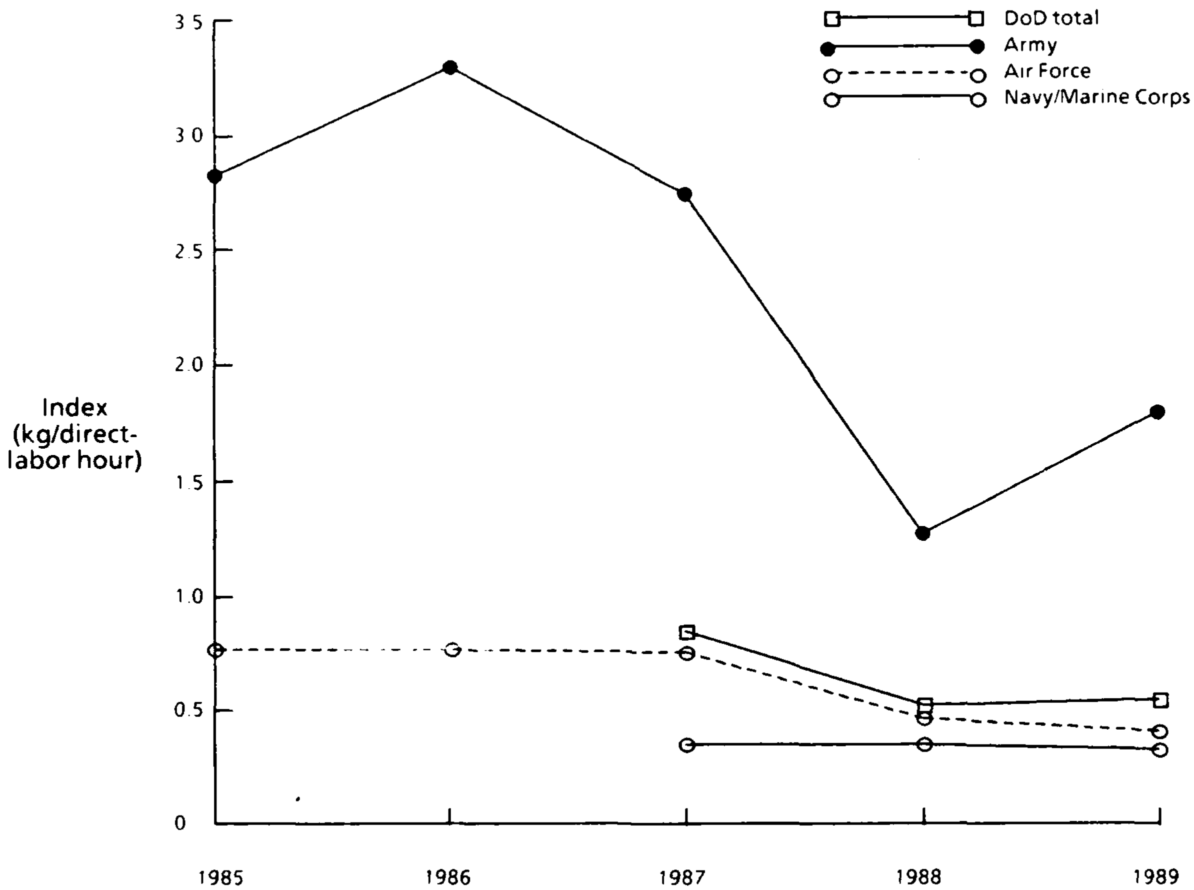


FIG. 3-2. HAZARDOUS WASTE DISPOSAL, 1985 – 1989

CONFIDENCE IN THE DoD INDEX

Because of a number of technical difficulties with the data used in developing the DoD index shown in Table 3-2, we have little confidence in the results. Those uncertainties occur in both the waste data and the workload data.

Waste Data Problems

The data in Table 3-2 were provided through a special ODASD(E) data call. We compared the figures reported for this one-time event with the figures reported by Army and Navy depots to their higher headquarters and with figures earlier reported by all three Services in the DESR. From that comparison, we found significant deviations among the three reports, as shown in Table 3-3. Without knowing the source of the data call figures, we cannot identify the cause of the significant differences; however, in our site visits we were able to identify some of the sources of the differences between the Service internal reports and the DESR quantities.

One of the primary sources of disagreement in waste data collection is the handling of "one-time" wastes. In the past, such wastes have been exempted from reporting as not reflective of the real operating environment. To the extent that such wastes are being generated at remediation sites – essentially brought in from outside the production process – we concur with that view. However, this exemption has often been used to incorporate spill waste and products that exceed shelf lives. In addition, a number of processes use large quantities of hazardous substances (plating tanks being the classic example); those substances are not waste during the long periods that the tank is in use but become waste in vast quantities as soon as the solutions must be drained. Such disposals are often counted as "one-time" wastes. All of these events are, in fact, consequences of the process, and failure to record such wastes anywhere ignores a very large source. Finally, many installations have been saddled with real one-time events in which large quantities of stored waste must be removed immediately; such events usually occur as a result of loss of a permit or some factor pertaining to the storage facility. The current year should not be excessively credited with such wastes, but that waste must be recorded somewhere in order for data to be consistent from one report to another. Without more comprehensive waste categories and counting rules, these problems will continue.

The DESR asked for disposal and generation data. In fact, a complete picture of the installation's hazardous waste status is offered in the DESR's recording of

TABLE 3-3

HAZARDOUS WASTE TOTALS

(Metric tons)

Report source	FY85	FY86	FY87	FY88	FY89
Army.					
Data call	63,932	78,261	60,996	28,648	30,951
DESR[a]	7,544	8,541	16,671	57,254	–
HAZMIN report	7,544	9,153	12,236	45,118	–
Air Force					
Data call	32,185	33,903	33,045	17,696	15,613
DESR	–	–	1,115,424[b]	15,011	14,757
Navy					
Data call	–	–	27,676	29,265	23,134
DESR[a]	–	–	31,520	20,795	47,429
NEESA	–	–	44,306	17,404	42,992

Note: HAZMIN = Hazardous Waste Minimization Report (Army); NEESA = Navy Environmental and Energy Support Activity.

[a] Army and Navy DESR totals are higher than the Service internal reports in that stored wastes are included for the DESR total.

[b] This figure includes a very large disposal at one of the Air Force depots. Without that, the figure for 1987 would be 31,706.

generation, storage, treatment, recycling, and disposal. Another category, "transferred to DRMS," used to be the cause of confusion as some installations double-counted waste in that category as well as another. The current DEMIS definition clarifies this situation, but eliminates all data requirements other than those for disposal data.

The equation,

$$treated + recycled + disposed + stored = generated$$

assumed in Service-level hazardous waste reports is incorrect because numerous installations have long-term storage facilities. Thus, stored waste may be counted twice or more – in the year it is stored, in years it remains stored, and in the year it is disposed of. An accurate picture would be obtained by separating the wastes placed

into storage during the reporting period from the wastes held over from the previous period.

The correct equation, therefore, is

$$\textit{waste in storage at start of year} + \textit{generated} = \textit{treated} + \textit{recycled} + \textit{in storage at end of year}.$$

To reflect this situation properly, DEMIS definitions should be modified to capture each of these categories.

Environmental compliance is an evolving task. During our site visits, we noted that every installation is now working on developing a detailed waste tracking system. Once those systems are implemented, DoD Components will be able to collect the data needed to provide a second level of detail below the macro index without placing additional data collection requirements on the installation. In an automated environment, asking for a report is not a major imposition as long as the structure and frequency remain consistent; the necessary data can be produced by the automated system quickly. However, in an atmosphere in which many unique systems are being fielded, DoD needs to set some standards quickly to ensure that each unique system collects certain minimum essential items of information. DEMIS modification now will place a minimal burden on the Services and depots; waiting too long will result in the loss of 1 or 2 full years of data.

Workload Data Problems

Our index data suffers from a weakness in the workload measure as well as in the waste quantity. Workloads reported to OSD under the DoDD 7220.29H requirement are accrued at the end of the relevant project. Whether the project is to overhaul a single unique engine or to apply a block modification to a fleet of 3,000 vehicles, all the work is reported as of the last day of work. Some of the projects span several fiscal years. The necessary data are available within each Service and could be provided to OSD in terms of work charged during the current fiscal year. In the meantime, however, the work recorded against any given fiscal year may bear no real relationship to the work actually performed.[1]

[1]For a more complete exposition of this problem, see LMI Report PL907R2. *DoD's War on Hazardous Waste: Measuring Hazardous Waste Reductions*. Douglas M. Brown and Paul F. Dienemann. January 1991.

INTERPRETING THE INDEX TRENDS

The value of first-level indices is that their portrayal of the current situation is rapidly understood. Figure 3-2 conclusively showed good progress in waste reduction. However, not all first-level index charts are as easily interpreted. Figure 3-3 illustrates some alternative situations and the implications that can be drawn from a first-level index. Each of these situations is likely to occur in the 1990s.

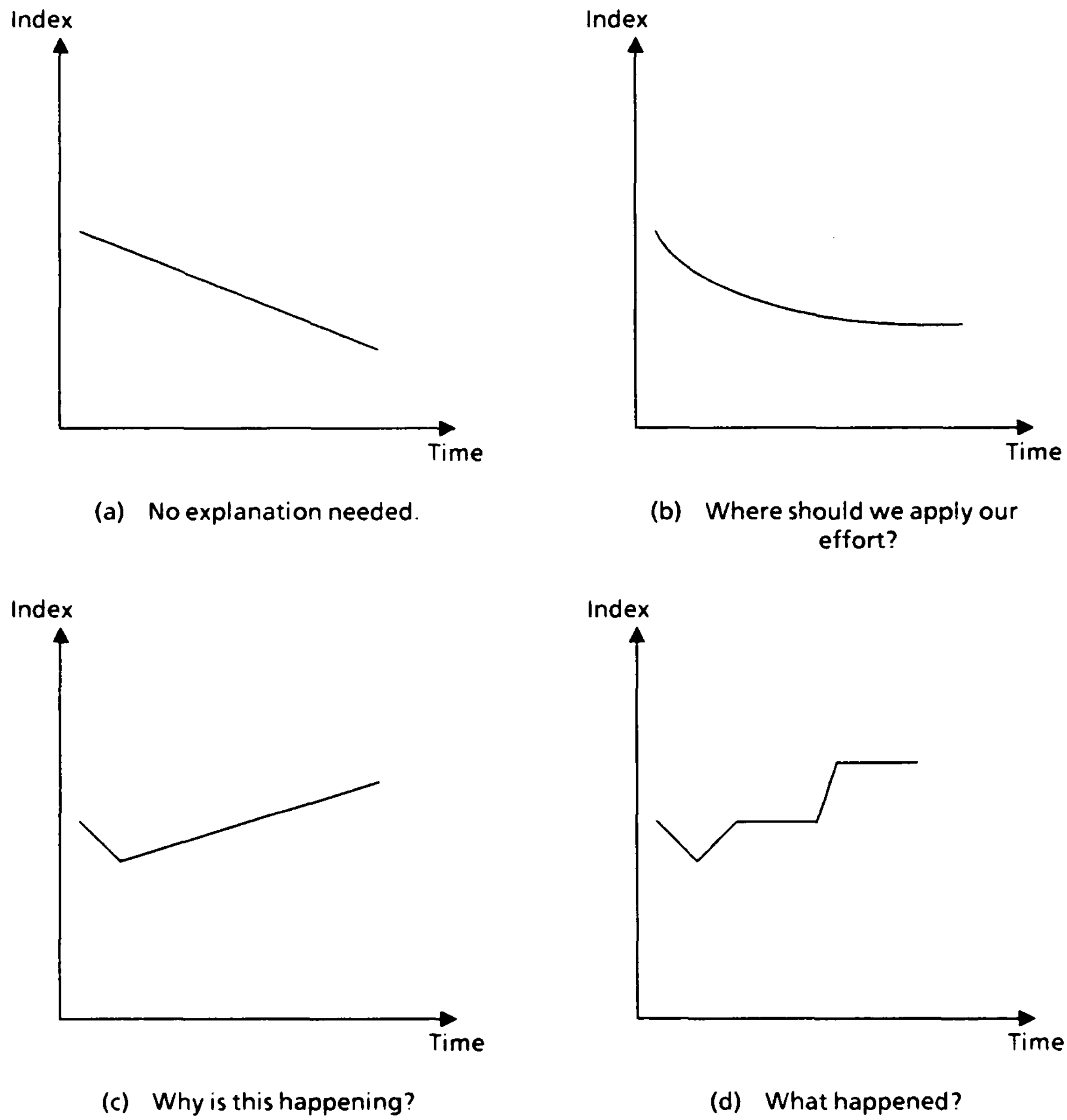


FIG. 3-3. POSSIBLE OUTCOMES OF THE MACRO INDEX

As long as the trend continues downward as shown in Figure 3-3(a), the program is succeeding although we have no information on how the success was accomplished. The trend shown in Figure 3-3(b) raises several interesting questions: What is happening? How do we break through this wall? What has changed? The trend in Figure 3-3(c) suggests that recent efforts to reduce hazardous waste are no longer successful and the entire effort is deteriorating. Finally, the chart in Figure 3-3(d) shows an operation that is out of control; recent efforts to reduce hazardous waste appear to be counterproductive. Then again, the surges may coincide with the implementation of new regulatory requirements or repair processes.

In short, first-level indices show what is happening, but they do not explain it. A first-level index is intended to reflect progress, but it does not answer questions: it generates them. The form in which the index is assembled may dictate the ability of the organization to provide answers. Without further inquiry, no effective management oversight or intervention is possible. However, the underlying detail must be available when the inquiry must be made. At present that is not possible. In Chapter 4, we investigate ways in which the index may be structured to allow it to be put to more effective use.

CONCLUSIONS

The issue of monitoring the Military Services' progress in reducing the amount of hazardous waste generated at their maintenance depots is clearly a formidable task. Simply measuring the amount of hazardous waste generated annually at the depots would be misleading because that measurement ignores the level of industrial activity associated with creating the waste. By using such a measure, one would not be able to determine whether hazardous waste was being reduced or less work was being performed.

We believe that use of a first-level index, showing the amount of hazardous waste generated (in kilograms) for every direct-labor hour applied at the depot, would be an appropriate tool for monitoring overall progress in the reduction of hazardous wastes. Such an index could be constructed, using data already reported to the OSD, for every depot, for each Service, and for all of DoD combined. In addition, with some thought to the measurement of workload, the index should be applicable to all types of DoD installations.

The first-level index has value as a quick reference point which allows managers at all levels of the DoD to determine the direction of the hazardous waste reduction program. We have identified that for workload data, the direct-labor hour model appears effective (given a change in reporting procedures to obtain current-year labor efforts). For waste data, no current data system is fully adequate. However, through the DEMIS data definition effort (if properly supported), total waste generation or disposal data may become available.

Total waste aggregations by chains-of-command, however, will not give OSD any insight into the index. To be truly effective, OSD must ensure that the appropriate level of supporting detail is either provided or available to explain the trends indicated by the macro index. Without such supporting data, OSD becomes dependent on case-by-case queries to the Service staffs. The complexities of hazardous waste measurement and depot maintenance operations offer strong evidence that a first-level index may not adequately portray the true relationship between waste generation and maintenance production. A more powerful and detailed methodology clearly is warranted. Possible useful disaggregations are explored in Chapter 4.

CHAPTER 4

SECOND-LEVEL INDEXING

THE PRODUCTION SYSTEM

In Chapter 2, we developed a general concept of a depot maintenance operation to define the concept of first-level indexing. We concluded that while first-level indices are useful to indicate overall trends, they must be supported by additional data to ensure that questions raised by the first-level index can be answered. In this chapter, we consider what measurements could contribute to such second-level indexing, again with a view toward minimizing the burden on the installations' staffs.

Compared to the simple schematic depicted earlier in Figure 3-1, the reality of a major industrial operation is more complex. In the still-simplified but more detailed view of a depot depicted in Figure 4-1, we see a single item of equipment entering the maintenance process for a specified purpose, passing through three specific repair processes (each having a different waste-generation profile), and emerging as repaired equipment with a waste byproduct. Notice that some waste is hazardous and some is not.

The first-level index, as shown, still relates the total hazardous waste to the total workload. If that index causes us to ask questions, such as why reductions appear to have stopped, the first level of detail should allow us to identify whether the problem is that waste is increasing or workload is decreasing. Beyond that, we must look at specific instances of wastes and workloads. In the context of Figure 4-1, we should ask whether the problem can be isolated to Process A, B, or C; that isolation is accomplished by calculating an index for each process. The process causing the problem will be the one for which the index is increasing. Again, the index will be the hazardous waste divided by the workload, and our challenge is to identify those quantities.

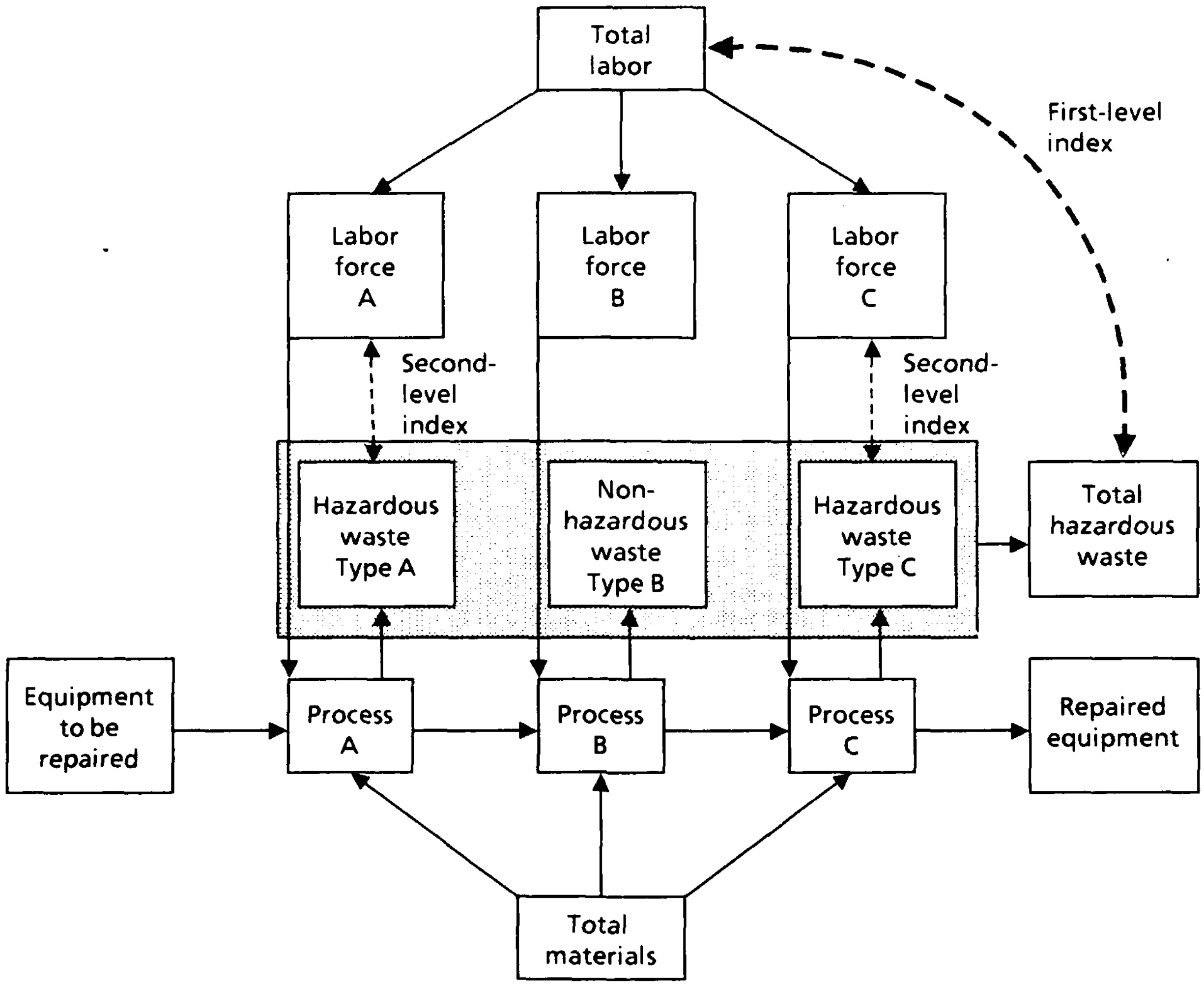


FIG. 4-1. PROCESS FLOW AND ASSOCIATED DATA

MEASURING THE SECOND-LEVEL VARIABLES

Workload Components

Since we have constructed our first-level index in terms of direct-labor hours, the second level of detail must conform to that measuring system. As noted in Chapter 2, detailed data collection systems are already in place at all depots. Those systems are designed to track every operation performed on the shop floor in order to ensure that work is being performed cost-effectively in comparison with historical standards. The question for workload detail, then, is not what data are available but what small part of the data bank will be useful. We should focus on the data that will

help to account for the amount of waste being produced. The existing control systems are able to disaggregate labor hours in terms of the items worked on, the jobs done on those items, or the work center that did the work.

Both the workload and waste generation originate on the shop floor where DoD maintenance facilities are typically organized into work centers within production shops. Data management systems record the nature of work precisely, including the equipment worked on (subject to the end item and component confusion noted earlier), the amount of time spent on the job, and the job classification of the worker. Our field visits indicate that, within certain broad categories (plating, painting, etc.), depot management staffs believe that specific waste generations can be tracked back to specific work centers and are often unique to those centers. In addition, we found a good commonality of work center organizations within the depots of all Services, so that a common terminology could be established. A more challenging problem is the continuous process of reorganizing work centers as reported by some organizations. That reorganization makes year-to-year comparisons of historical work center data impossible.

To add detail to the macro index in the workload area, then, the workload can be broken out by work center. An initiative to achieve a common understanding of processes is needed to permit correct aggregation and reporting of depot workloads; however, that is a matter of one-time reports programming. Such reporting would thereafter be electronic; and thus, the workload on the depot operational or environmental staffs would not be increased.

Waste Components

The definition of waste is based on its composition, not its source. Thus, given the same contaminants, solvent is solvent, and whether it comes from a ship process or an aircraft process is irrelevant. Data on waste are already collected in voluminous form to satisfy environmental law. Each depot reports its waste to Federal or authorized state EPA hazardous waste monitoring programs. At most depots, those reports are prepared manually by the environmental staff, so aggregation of these data would not be easy. However, as waste tracking systems are implemented by each Service in the near future, aggregation should pose no burden on the installation staffs.

Some aggregate data already exist. Waste that is manifested off the depot for disposal is categorized by the somewhat more compact categories of waste established by the Department of Transportation, and (for waste handled by the DRMS) by the contract line item number (CLIN). There are several hundred such numbers. Even this number of waste categories is too great to use effectively.

Finally, the Army and Navy (including the Marine Corps) have each established some two dozen waste aggregation definitions for annual reporting. The aggregations are very similar, as shown in Table 4-1; the Air Force has no such aggregation program, but Air Staff representatives have stated that they would be able to concur in a properly constructed set of definitions. For our purposes, the advantage of this aggregation is that it is basically done by process or work type; thus, cross-referencing the waste produced to our previously suggested work-center-based workload measurement allows for a very powerful second-level index that is consistent with the macro index. Again, this table is appropriate for maintenance depots. Other major hazardous-waste-generating installations may require some additional process types to be defined.

In Chapter 2, we considered tracking waste by disposal cost and by toxicity. We concluded that, for the present, additional work remained to be done before such measures could be adopted. Thus, we will not concern ourselves at this point with how those measures could be used in a second-level index. However, once the waste tracking systems are in place, the measurement of the waste, which is now done by weight, can easily be expanded to record the disposal cost, probably by data transfer without requiring human input. Toxicity estimates can also be added in an automated way once the proper methodology has been established.

Regulatory Changes

During the course of the study, we were exposed to serious reservations about any form of hazardous waste measurement because all depots expected a significant increase in hazardous waste in the near future as a result of Federal or state adoption of more stringent standards. [In essence, waste that was not previously considered hazardous is now so considered.] Operations in several depots were massively dislocated, resulting in greatly increased disposals of hazardous waste, because of the arrival of new regulators who decertified treatment or storage facilities previously found acceptable. Although regulatory impact does not affect the index

TABLE 4-1

SERVICE-LEVEL PROCESS CODES

Army	Navy
Electroplating	Electroplating
Cleaning and degreasing	Pipe flushing; boiler cleaning; solvents/degreasing; torpedo cleaning
Metal finishing	Industrial operations
Painting	Painting
Depainting	Abrasive blasting; chemical stripping
Load, assemble, and pack	Preservation and packing
Propellants, explosives, and pyrotechnics	Ordnance manufacturing
Munitions demilitarization from stock	Ordnance evaluation, ordnance demilitarization
Pesticides	Pesticides and herbicides
Vehicle maintenance	Fluids changeout
Electrical maintenance	Electronics and refrigeration
Battery shops	Battery shops
Laboratory operations	Research and development
Industrial waste treatment plant sludge	Industrial waste treatment
Other; photo and X-ray	Miscellaneous
Expired shelf life[a]	Ship's off-loaded stores; shelf-life (non-ship); HAZMAT downgraded[b]
One-time disposals[a]	One-time waste; RCRA corrective action; Installation Restoration Program
Spill cleanup[a]	Spill cleanup
Forced obsolescence[a]	Forced obsolescence
	Firefighting
	Industrial maintenance (facilities)
	Bilge water
	Boiler lay-up

[a] Currently exempted by the Army for hazardous waste totals.

[b] "HAZMAT downgraded" means hazardous materials (as opposed to waste) that had to be disposed of because their shelf-lives expired before they could be used.

mathematically, it can be a significant factor in explaining (or predicting) sudden dislocations in the index. As such, DoD must develop a means for measuring this phenomenon. Regulatory impact is a critical data element in dealing with the reduction of hazardous waste.

The measurement of changes in the regulatory environment is quite easy to observe but not easy to measure. OSD does not need to collect information on the incidence of Federal legislation because its own staff should be aware of it. Installations are, however, affected by a number of overlapping jurisdictions. A solution might be to use the waste categories to classify legislative impacts in a qualitative way. DoD could develop a new DEMIS table on which installations could report that the waste in a given category would or would not be affected by changes to laws in that year. If changes are expected, a short addendum could note the law, give a rough estimate of the expected change, and explain the reason.

The other reason for regulatory changes is personality based. Such a condition is extremely hard to report on without casting aspersions on individual representatives of other agencies who are only trying to do their jobs; in fact, the *better they do their jobs, the more severe their impact may appear.* At the installation level, the only measure is a subjective one of rapport. That rapport can be changed by installation action to build (or destroy) a relationship; it can also be affected by turnover in either the installation or regulatory staff. Because of the subjective aspects of this problem, data should only be collected on the quantifiable question of turnover.

Data are not now formally collected on this issue. A new DEMIS table could record the turnover of depot environmental staff. Measuring regulator turnover is possible since for most installations, the state and local agencies have employees who are the regular points of contact with the installation. The DEMIS could report the tenure of the point of contact, a yes-no option to indicate a new point of contact for the current year (allowing the system, over time, to go back and search earlier years to determine the tenure), or a qualitative measure of rapport. While the last measure might be the most useful, such data collection efforts risk the perception by regulators that DoD is simply making excuses for nonperformance.

Figure 4-2 is a form that could be used to capture regulatory change information at each depot. That form calls for the preparation of comment sheets,

which could be used by Service and higher level environmental staffs in assessing the overall impact of new or proposed legislation.

Staff turnover	Air	Water	RCRA[a]
1 Enter "Y" in any media column in which the local representative is new to the job this fiscal year:			
a Federal EPA (local representative)			
b State agency			
c Local agency			
2 Installation environmental staff:			
a Total years of Federal environmental professional experience			
b Number of environmental professionals.			

3 Estimated effect of new laws	This FY: Enter number of kilograms of new waste estimated caused by changes to law (attach comments)			Next FY: Check block if new actions under discussion will have effect next FY (attach comments)		
Waste category	Federal	State	Local	Federal	State	Local
Total						

[a] Resource Conservation and Recovery Act

FIG. 4-2. REGULATORY IMPACT REPORT

CONCLUSIONS

The complexities of hazardous waste measurement and depot maintenance operations offer strong evidence that a first-level index may not adequately portray

the true relationship between waste generation and maintenance production. A more powerful and detailed methodology clearly is warranted.

We believe that second-level indices, accounting for various types of hazardous waste and maintenance processes but still using the basic measures of kilograms of waste and direct-labor hours, would provide the necessary insight into the waste-disposal/maintenance-production relationship. Those indices also would build upon data readily available in both the environmental and maintenance communities.

Given a common understanding of the aggregation categories, data can be structured within a second level of detail with little additional effort on the part of the installation staff. By using a work-center-based approach, we can use the existing depot management system to provide the required data. In taking advantage of the expected arrival of waste-tracking systems that can track specific wastes back to the process in which they are used or to the work center in which they originate, we can identify the generation or disposal of waste in each process type through the reporting of information easily produced by the installation staffs through their systems.

The identification of waste by type and process also allows for an evaluation of the effect of changes in the regulatory process. As a rule, such changes are focused and affect specific products or processes. Thus, when our DoD-wide total output of waste increases as a result of the redefinition of motor oil as a hazardous waste, we should see an increase in waste in those processes and nowhere else.

The identification of regulatory effect is more difficult and certainly requires an extra effort by the installations because that information is not currently provided in any Service.

In the next chapter, we explain how DoD managers at all echelons can use the two-level indices we have suggested as management tools. In Chapter 6, we lay out an implementation plan for such a system.

CHAPTER 5

USING A TWO-LEVEL INDEX

In the preceding chapters, we proposed the use of indices for monitoring the Military Services' progress toward meeting the JLC goal of cutting in half the amount of hazardous waste generated at Service maintenance depots. We proposed the use of detailed, second-level indices for additional insight into the complex relationship between waste generation and the level of industrial activity. In this chapter, we explain how such a two-level indexing system would operate and what type of management data it might provide.

INSTALLATION STAFF ACTIONS

The data collection and analysis process begins at the installation level. Data are summarized from daily transactions and reported at the end of the year through the chain of command until eventually a Service summary is provided to ODASD(E).

At every installation, as waste is produced, it must be tracked. That tracking is now done on local computer systems. When a waste barrel is identified, environmental staff members assign it a label and enter the contents information into a database that contains, among other things, the information listed in Table 5-1. The only information shown there but not currently collected is the process code. Depending on the complexity of the depot's operations, we may be able to link the waste code or work center directly to a process, but we have not assumed that linkage to be possible.

As required, but as a minimum annually, a DEMIS report is prepared. The necessary information is derived from a combination of the work center code, the process code, the barrel weight, the ultimate disposition, and the date the barrel was filled. Those data can be combined on any database system to produce a written or digital DEMIS input report, whichever is required by the depot's major command. The basic format that would be required is as shown in Table 5-2.

TABLE 5-1

WASTE-TRACKING DATABASE

Drum serial number	:
Date initiated	:
Contents (EPA ID)[a]	:
Contents (description)	:
Work center collection point number	:
Process code	:
Date filled and sealed	:
Weight when full	:
Date delivered	:
Delivered to	:
Receipt serial number	:
. . .	
Other data desired by installation	
. . .	
Disposition status	:
Disposition date	:
Disposition manifest number	:

[a] EPA ID: Environmental Protection Agency hazardous waste identification.

In addition, the base environmental staff would have to add some qualitative data about regulatory impact. We have already suggested (in Figure 4-2) a table that would meet this need. The form is designed for easy transfer to data entry.

The depot production staff supports the process indirectly in ensuring that work management data are maintained in the depot's production control system. Those data are then provided to OSD through the depot's major command, which produces the summary reports. However, if the depot wishes to review its own performance using the hazardous waste tracking system, its production staff could run the same standard report to generate the required workload data. Depot staff could then compare that workload data against the depot's reported waste disposal quantities to determine the depot's current index.

TABLE 5-2

HAZARDOUS WASTE REPORT

(Notional installation, 1991)

Waste category	Kilograms generated	Disposition in kilograms				
		In storage at start of year	Recycled	Treated	Disposed of	Placed in storage
: : : : :						
Total						

MAJOR COMMAND AND SERVICE STAFF ACTIONS

The major commands and Services consolidate the reports of the installations and forward them to OSD. The formats they see should be unaltered from those already shown except that at some point the data would be converted from paper to electronic form. In addition, the installation-level comment sheets would be consolidated into a Service-wide summary rather than being transmitted individually to OSD. The direct chain of command varies slightly for workload data, which would be transmitted to the Defense Manpower Data Center and thence made available to ODASD(E).

Again, the index is fully available to the major commands and Services for their own analyses.

OSD STAFF ACTIONS

The required waste data to support hazardous waste indexing can be provided through the DEMIS. The automated system on which DEMIS is to reside should be able to handle, or provide interface to, the rudimentary graphics needed to produce the trend charts.

Upon receipt of the DEMIS data, the regulatory assessment (if it is not contained in DEMIS), and the workload data, ODASD(E) is able to make a relatively sophisticated analysis of the hazardous waste situation. Given our conviction that waste figures may increase dramatically over the next few years because of new regulatory initiatives, we have constructed some notional data to exemplify the functioning of a macro and a second-level indexing system. In Figures 5-2 through 5-5, we show a series of graphics to illustrate the power of this data system. None of the analysis requires OSD to review installation-level data.

At present, DoD has eight items of information – two items of information (waste and workload) for three Services and two for the DoD total. Other than inventory data, no other information is provided. That situation is depicted in Figure 5-2, using hypothetical data. On the strength of the data, it seems that Service C creates most of the waste and so should receive the bulk of the attention. Yet Service C's index is declining. Service A, however, seems to be losing ground based on its index; but its overall volume of waste is low.

Using current data systems, DoD would be faced with the choices of placing its emphasis on the Service with the most waste (but a working reduction program) or the Service with a defective program (but relatively little waste). Either solution seems inadequate.

With a second-level index in place, however, we have perhaps 15 categories of waste across three Services, along with corresponding workload figures. That situation is depicted in Figure 5-3, again using hypothetical data. The available data include disposal information for each of the defined waste categories within each Service. From this, of course, one can obtain DoD and Service totals; but what this system offers that the earlier macro index did not is the ability to look at major issues across Services. For instance, we can see (using hypothetical data) that DoD really needs to place emphasis on reducing industrial and plating waste, perhaps across all Services.

Further, it is clear that the previous investments to reduce bilge waste have been effective, but it is now time to redirect the effort into other areas.

In a similar way, a Service could review its own performance, as shown in Figure 5-4 and Figure 5-5.

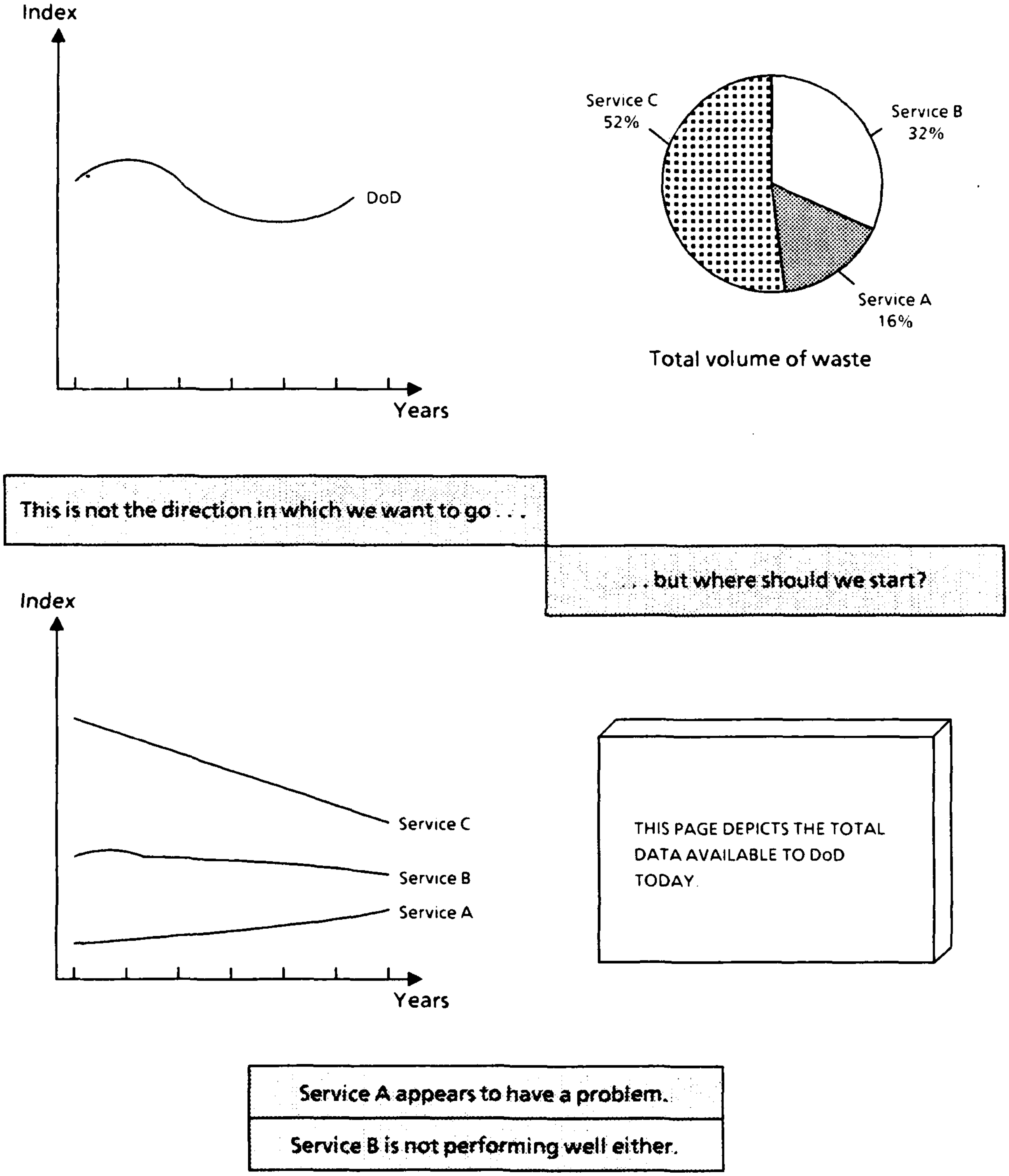


FIG. 5-2. DoD HAZARDOUS WASTE: FIRST-LEVEL INDEX

(Hypothetical data)

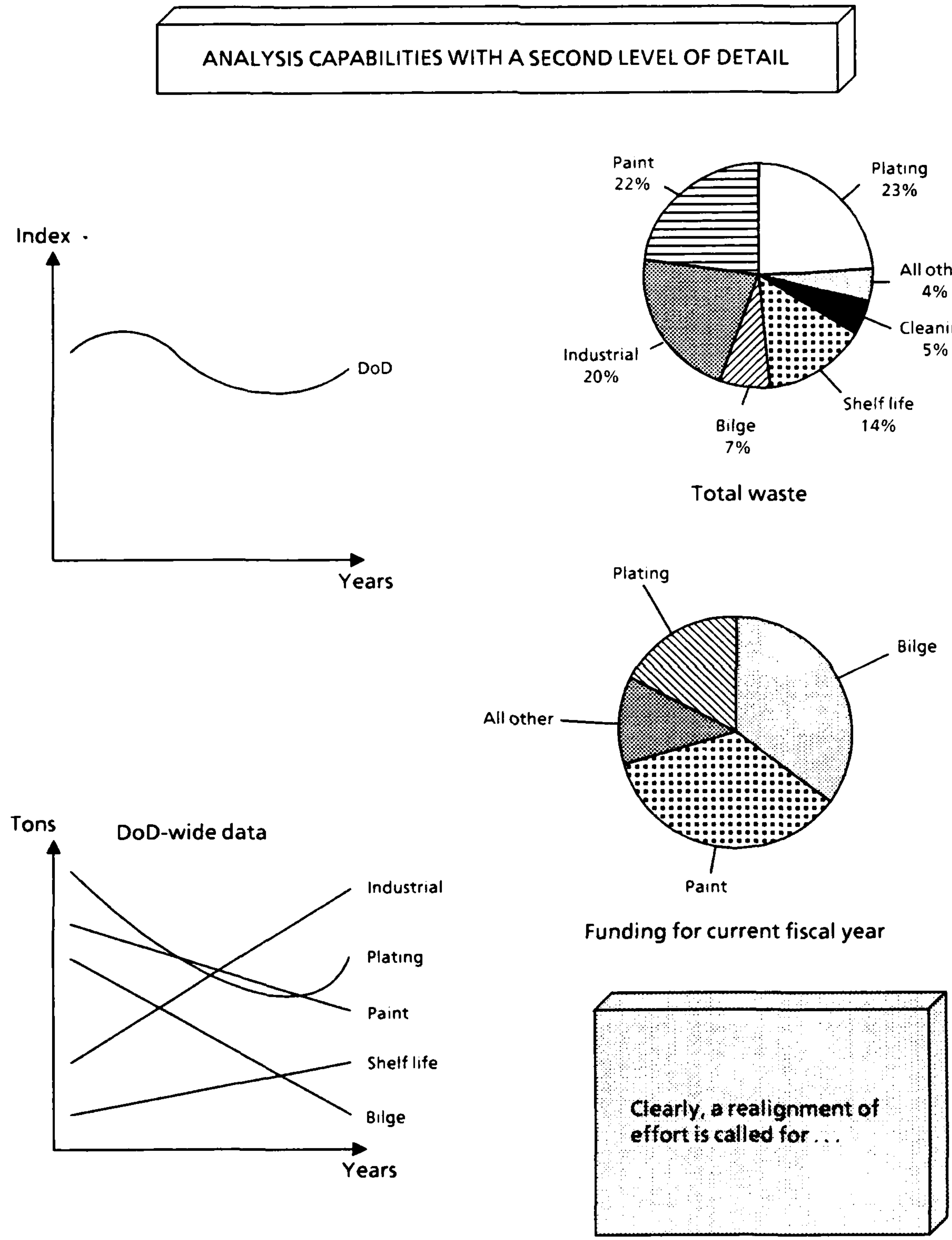


FIG. 5-3. DoD HAZARDOUS WASTE: SECOND-LEVEL INDEX

(Hypothetical data)

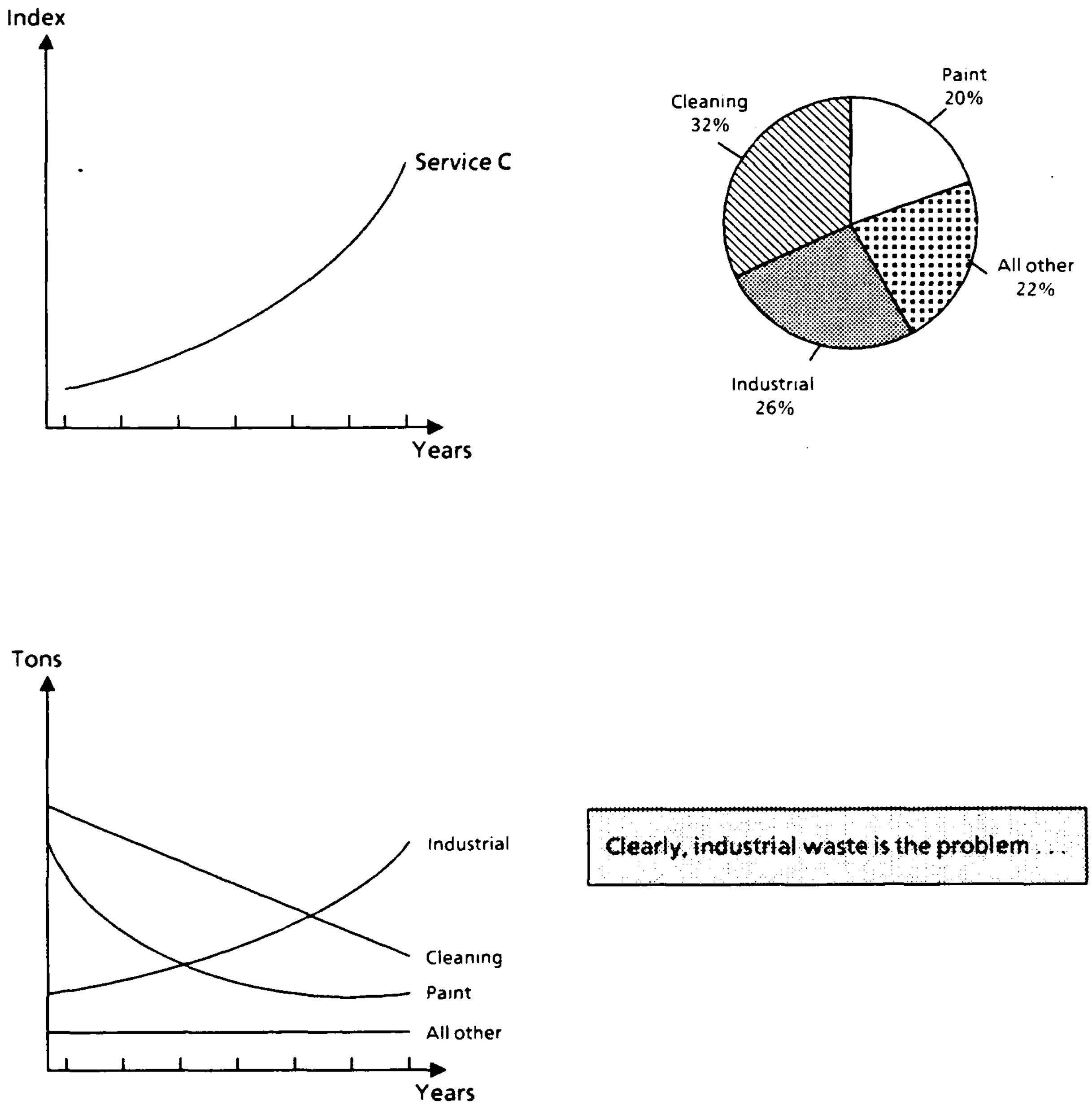
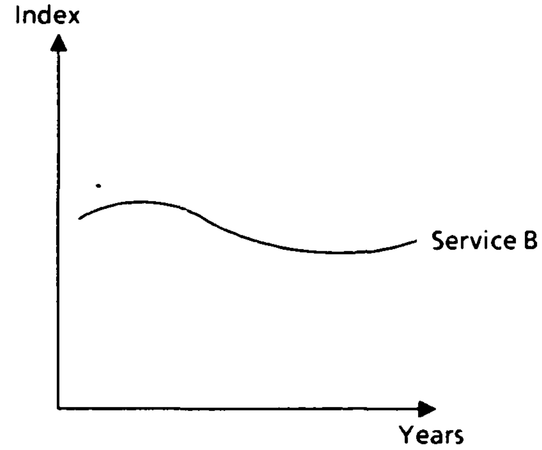
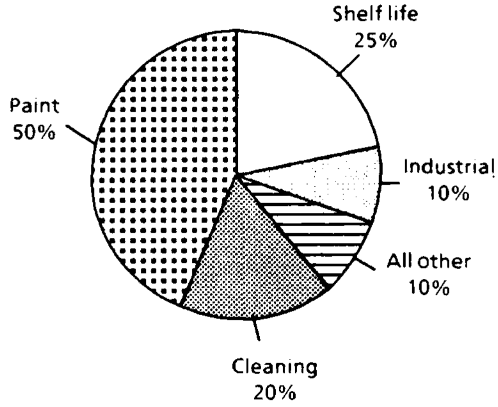
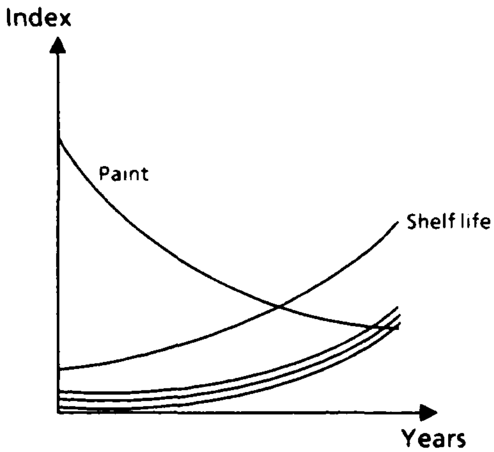


FIG. 5-4. SERVICE C HAZARDOUS WASTE
(Hypothetical data)







All waste is increasing except paint. This Service should be commended for its progress in its major waste stream (painting) . . . and be helped to start thinking about other streams.

FIG. 5-5. SERVICE B HAZARDOUS WASTE

(Hypothetical data)

In addition, we have regulatory impact information, and we have final disposition figures. At no point is OSD required to obtain installation data to draw some significant conclusions. Obviously, we can only answer those questions we have foreseen, but the point is that with very little installation or intervening staff effort, DoD can develop a logical approach to the problem, formulate some policy options, and create a consensual, targeted approach to what was formerly a random process. The same capability would be available to each level of command in each Service through the same procedure.

CHAPTER 6

CONCLUSIONS, RECOMMENDATIONS, AND IMPLEMENTATION

In the preceding chapter, we showed the feasibility and value of using an indexed hazardous waste measurement system to monitor DoD's progress in hazardous waste reductions. In this chapter, we summarize our conclusions, present our recommendations, and provide an implementation plan with which to put the measurement system into place.

CONCLUSIONS AND RECOMMENDATIONS

Overall Index Form

We found that an abundance of data is available to support a measurement of hazardous waste by weight and to account for some of the variation in the waste by levels of industrial activity. That activity is measured in great detail in a number of ways, but direct-labor hours appear to be as effective a measure as any. Since Federal laws require or allow reporting of hazardous waste data in kilograms, that measure should be used by DoD as a standard.

We found that DoD has reduced its generation of waste significantly although those reductions occurred during a period of reduced workload. We found that we can construct an index to compare waste to labor and that even when differences in labor levels are considered, DoD appears to be making progress in reducing hazardous waste. That index confirms what is evident from visual inspection of the DoD depots. Since the primary objective is to limit potential risks to the environment, OSD should focus in its data collection on the most significant actions (treatment and disposal) rather than concerning itself at this point with recycling and generation issues.

> **Recommendation:** *ODASD(E) should use a waste-to-workload index as an overall management indicator. The index should compare kilograms of waste disposed of or treated to direct-labor hours expended.*

Additional Detail

We observe a number of trends, especially in changing environmental laws, which could lead to a possible increase in the waste index over the next few years

rather than the decrease for which DoD is striving. In such conditions, an index without the ability to seek a lower level of detail to explain changes has no value because it can neither explain the deviations nor identify potential problem areas or solutions.

Recommendation: *ODASD(E) should adopt a standard set of waste and workload categories that will be applicable across all Services.*

Data Systems

Obtaining these data will pose little burden on installation staffs because the raw data are being collected today. The installation's only additional activity will be to program a formatted report into existing automated systems. However, most installations are developing their own unique waste-tracking systems, and those systems are not yet implemented widely. OSD should develop its category definitions as quickly as possible.

The decision on whether the data should be collected routinely by OSD or whether those data should simply be available in the event they are needed (as is not now the case) is a matter of management style and focus. However, to the degree that funding decisions are being made in the hazardous waste area, OSD needs that information.

In addition to technical process issues, a particular area of concern is the unilateral adoption by states of stricter environmental standards than those of the Federal Government; OSD needs to have an insight into the effect of such activities as they affect the apparent success of reduction efforts.

Recommendation: *ODASD(E) should include data fields in DEMIS to assess the regulatory climate faced by DoD activities.*

Measures of Risk or Cost

We observed that there are some conceptual problems in defining waste as a volume or weight measurement. The real environmental goal is to reduce the risk to health and natural resources while meeting operational goals under constrained financial resources. Thus, we should define better measures of waste to assess progress in minimizing risk while maintaining cost-effectiveness. The methodology

for such definitions is not in place today; thus, we must use weight. In the long run, however, DoD should move toward risk and economic measures.

Recommendation: *ODASD(E) should determine how to implement the measurement of progress in hazardous waste reduction in terms of reduced health risks and cost-effectiveness.*

DoD-Wide Index

Finally, the index has been reviewed only in terms of its applicability to maintenance depots. While those installations produce much of the hazardous waste disposed of by DoD, many other installations generate large quantities of hazardous waste. The proposed indexing concept can be applied to any installation, but the process codes might have to be modified.

Recommendation: *ODASD(E) should investigate how to apply the indexed measurement of hazardous waste to all DoD installations.*

IMPLEMENTATION

Among the questions that DoD needs to answer before it can make a credible judgment on the Military Services' progress are the following:

- What should be the form of the second-level indices and how would they be used to explain variations in the first-level indices?
- What is the relationship among production shops (or work centers), the industrial processes proposed by the Army and Navy, and the workload data reported by maintenance depots?
- What is the effect of data on hazardous waste lagging data on maintenance production by a minimum of 3 months?
- What ODASD(E) actions need to be taken, not only to answer the above questions but to launch implementation of a DoD-wide capability for tracking Military Service progress toward the 50 percent reduction goal?

In the balance of this chapter, we present a progression of management actions that answer the above questions, and at the same time, lead to the implementation of second-level indices for tracking the generation of hazardous waste at DoD's maintenance depots.

MANAGEMENT ACTIONS

The OSD must initiate the implementation process by defining its program; that is, OSD must determine what it wants to do. We have suggested four key data-related actions: defining the indices, refining process categories, resolving data issues, and determining how to monitor regulatory impacts. Once this program definition is completed, OSD must coordinate its actions with the Military Services and then publish a directive to initiate the data collection process. Then, OSD must monitor the program. The collected data must be reviewed and as a result of the trends shown by the indices, management actions must be taken. Finally, OSD must make improvements to the program as time progresses.

Those actions are summarized in Figure 6-1.

Program Definition

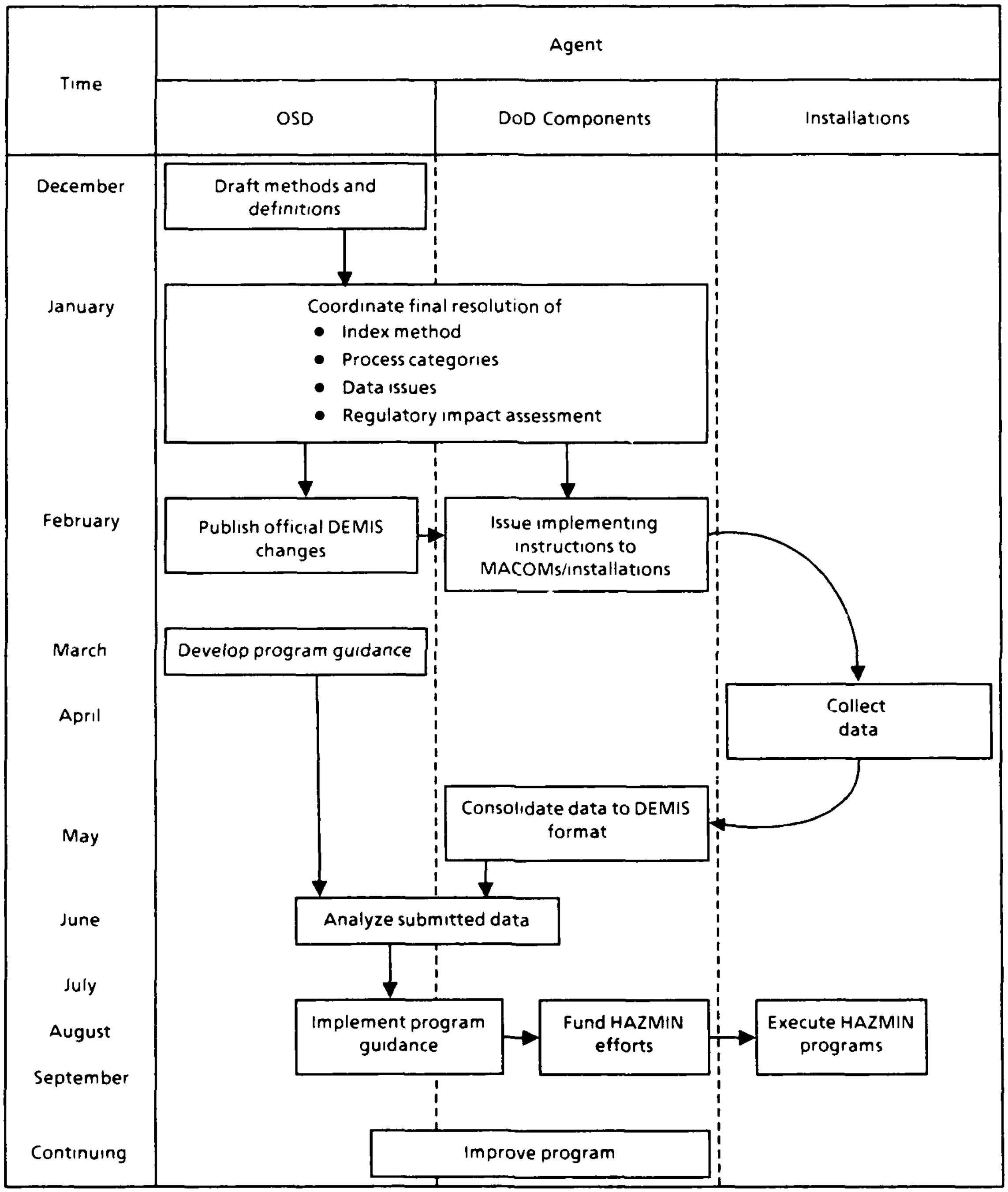
Six steps must be taken by OSD to develop the outlines of its intended program.

Define Indices

The first-level index for any depot is defined as the total amount of hazardous waste, expressed in kilograms, generated as a byproduct of the maintenance function, divided by the total number of direct-labor hours expended by depot maintenance personnel during a given period of time. The typical time period is 1 year, but it also may coincide with a shorter reporting time period, which could be monthly or quarterly as directed by the parent Service.

This depot index also leads directly to a Service-wide index, which is obtained by summing the waste generated by all depots within a Military Service and dividing the result by the total number of direct-labor hours applied by those same depots. A DoD-wide index is similarly computed by summing the waste generated by the Services and dividing it by the total direct-labor hours applied by the Services.

The second-level indices are developed in a similar manner. The numerator in the second-level index is the total weight of one of "*N*" different types of hazardous waste generated by one of "*M*" maintenance processes. The denominator of the second-level index is the total number of direct-labor hours expended by the work center or centers that generated the hazardous waste. At each level, therefore, we will have as many second-level indices as we have waste processes. The sum of the



Note: MACOMs = major commands

FIG. 6-1. IMPLEMENTATION ACTIONS

(Responsibilities)

direct-labor hours over all *M* processes will exceed the total number of direct-labor hours for that depot to the extent that work centers contribute to more than one waste category.

We do not advocate the development of weights for the second-level indices to create some form of composite index. Such an index would not add any insight to the waste management process and would only be an invitation to debate.

Refine Process Categories

The development of standard, DoD-wide process categories is key to the effectiveness of second-level indices. The Army and Navy have each made some progress in grouping their industrial processes while considering waste generation issues, but more progress is required. DoD needs to develop standard categories that bridge all Military Services and (to the extent practical) build upon existing depot-maintenance organizational structures and workload-reporting procedures.

The ODASD(E) should actively participate in the development of standard process categories. With assigned DoD-wide responsibilities, the ODASD(E) can bring the necessary parties together, prescribe the ground rules for development of the categories, and direct implementation of the resulting products.

Resolve Data Issues

Because of the complexity of monitoring the Military Services' progress toward meeting the 50 percent reduction goal, we are not surprised that significant data problems exist. Most of those problems, however, can be resolved directly through a common understanding with the Military Services of the data definitions and the reporting protocols.

Wastes that are created as direct byproducts of the repair processes at individual maintenance depots need to be included in the hazardous waste data for those depots. If they are excluded, any success attributed to the JLC's hazardous waste reduction initiative would be tainted. OSD needs to define the wastes in such a way that none of them is excluded while allowing the Military Services to identify those wastes (such as RCRA remediation disposals) that they feel should not be charged against industrial processes.

The discrepancy between the reporting of workload for all completed job orders at the end of every fiscal year and the reporting of hazardous waste information on a calendar-year basis is confusing. The 3-month lag is not a problem because the fate of the waste, as a practical matter, lags the production process by several weeks. Thus, the inconsistency with all other Federal reporting periods may turn out to be an advantage.

However, the issue of when workload is reported needs to be resolved because it seriously distorts the data. The data are retrieved quite easily by the installations since labor hours are recorded against jobs by date; all that is needed is for ODASD (Logistics) [ODASD(L)] to require labor hours to be reported in current fiscal years as well as in job-order format. ODASD(E) must request ODASD(L) to do so and coordinate the details of the information exchange process.

Develop Regulatory Impact Assessment Capability

The DoD needs to be more attentive to the effects of changes in definitions of hazardous waste and in regulatory personnel overseeing the depot's hazardous waste programs. Those changes create a severe disruption in the progress of ongoing waste-reduction programs. If the changes are noted, however, then DASD(E) can make a credible case for adjustments to reported data.

Coordinate with Components

Once OSD specifies the data definitions and reporting requirements, the DoD Components should be consulted to ensure that the proposed program is adaptable to the context of all the installations affected. ODASD(E) should emphasize in this process that the implementation will be iterative and that adaptation over time is expected.

Publish Definitions and Requirements

Once consensus is reached, OSD must move rapidly to publish its data definitions and reporting requirements. Installations need time to gather data and some questions will have to be fielded. Without the basic documentation, no installation can respond.

Develop Program Guidance

Although a better time to have "sold" the program would have been prior to issuing data definitions, the constraints of time prevented that. Thus, ODASD(E) needs to use the available period between the issuance of the definitions and the actual processing of the data by the Services to explain what it proposes to do with the data. That process will, in addition, help to shape ODASD(E)'s analysis process.

Define the Program

We recommend that the hazardous waste index be used for four purposes.

- Reporting DoD progress
- Identifying areas of strengths and weaknesses by process
- Assessing the appropriateness of hazardous waste reduction expenditures
- Supporting requests for hazardous waste R&D funding.

Those purposes are key management issues for ODASD(E).

Reporting DoD Progress

The first- and second-level indices should be included in DoD's annual report on the environment. The DoD Components' first-level indices should also be included, both for comparative purposes and because Congress and the public will demand the data in any case.

Identifying Strengths and Weaknesses

Using a second-level index, managers at all levels can identify organizations that are making progress in specific process types and can coordinate the transfer of ideas from a successful organization to another that is having problems in the same area. That index will also identify areas that are experiencing DoD-wide problems (or successes).

Assessing the Appropriateness of Expenditures

In past years, all Services have invested significant funds in hazardous waste minimization. That investment was done largely on the basis of anecdotes or the opinions of a few experts and had varying degrees of effectiveness. A second-level index will allow managers to determine whether the investments are being made in

the areas in which the most significant problems exist and, over time, will allow them to determine the effect of the investments.

The ODASD(E), while not directing the expenditures, can use the index to identify areas in which investments are needed and can then compare that with Service hazardous waste minimization plans. If the plans do not conform to the problem areas, ODASD(E) can pressure the Services to realign their efforts.

Supporting Requests for R&D Funding

Managers at all levels can use the second-level indices to identify areas in which no organization seems to be making progress. In such cases, transferring ideas will produce little further effect. The index will help make a much more powerful case for the need for R&D in those processes.

Monitoring the Hazardous Waste Reduction Program

As the program is initiated, installations will begin to collect data, which will be forwarded through the major commands to the Service staffs and thence to ODASD(E). When the data arrive, ODASD(E) must have a plan for using those data. Simply recording them is not enough.

Receive and Analyze Data

During the time that the data collection process is continuing, ODASD(E) needs to coordinate the precise means of delivery of the required data.

We recommend that the data analysis identify the following:

- First-level indices for OSD and each DoD Component
- Second-level indices, DoD-wide, for each defined process code or any appropriate groupings of processes
- Second-level indices for Components for which progress in the first-level index suggests difficulties
- A regulatory impact analysis to indicate what the index would look like if the anticipated impacts occurred.

Implement Program Guidance

Once the indices have been prepared, managers at all levels can use them for the purposes indicated earlier: reporting progress, identifying strengths and weaknesses, assessing hazardous waste minimization plans, and supporting requests for R&D funding.

The DoD Components' reactions to this implementation will be to make the appropriate adjustments in their hazardous waste minimization programs, chiefly by adjusting their funding plans. Installations will receive the funding and execute approved projects and activities.

Improve Program

Finally, continuous improvement in the program will be needed. Through program execution, weaknesses in the data definitions will be identified and additional uses for the indices will arise. Installations other than depots must be included in the program, and modifications will have to be made to account for different processes and workload measures. And, as we noted before, measures of risk and cost need to be developed and refined.

Timing

In Figure 6-1, we show the responsibilities of OSD and the DoD Components in implementing the program. Figure 6-2 provides a slightly more detailed breakout, which focuses on the activities required within ODASD(E).

Those charts depict immediate actions. The program improvement actions cannot begin in full measure until after the first round of data analysis is complete.

CONCLUSION

In this chapter, we presented our recommendations and an implementing plan that would provide ODASD(E) and environmental managers at all levels of DoD with a relatively sophisticated management tool. That tool will pose little additional burden on the installations because it relies almost exclusively on data available today. The hazardous waste indexing program presented in this report can be a valuable asset to DoD in its efforts to reduce its output of hazardous waste.

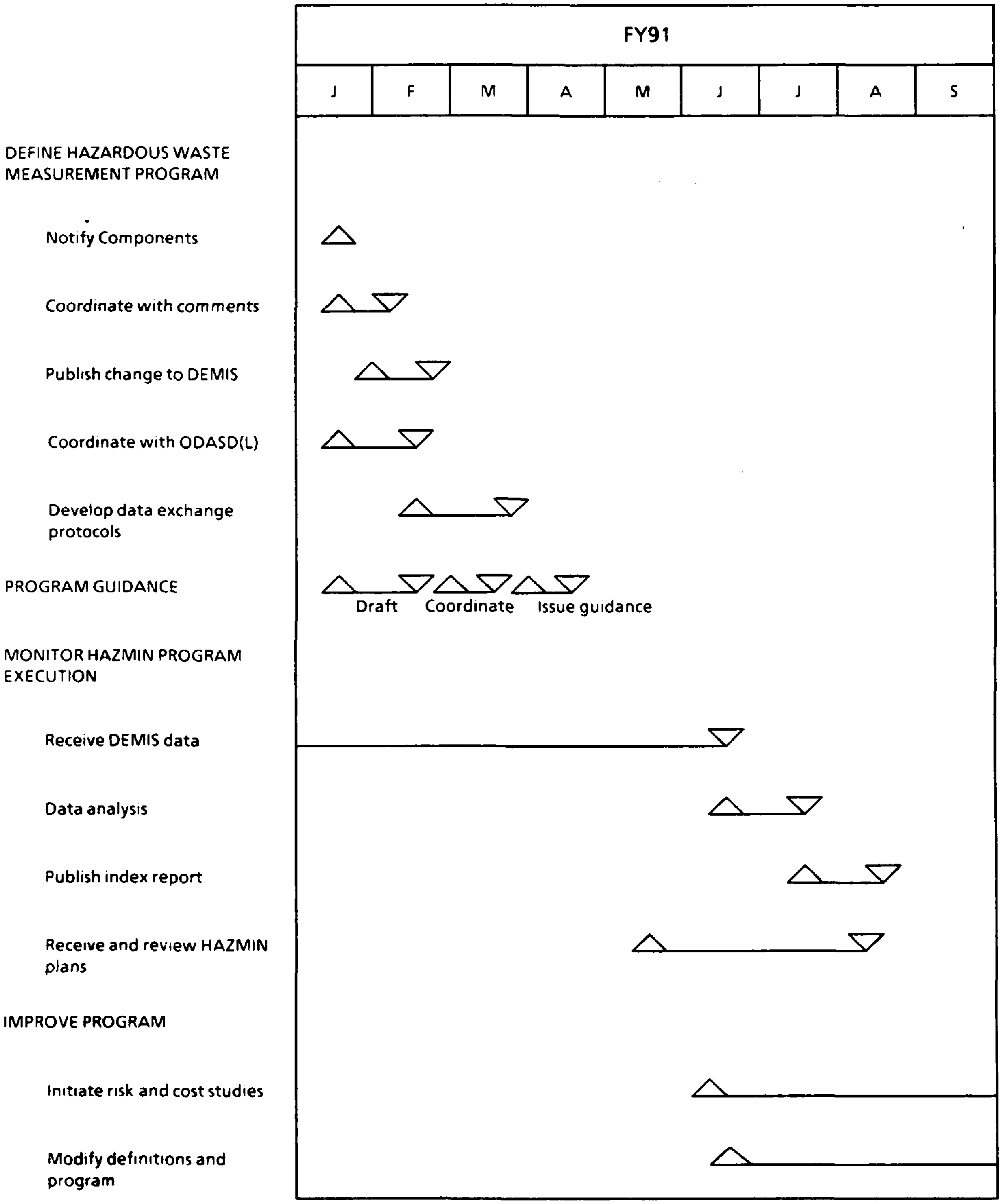


FIG. 6-2. ODASD(E) TIME LINE

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13. ABSTRACT *(Maximum 200 words)*

In an earlier study on DoD's war on hazardous waste, we investigated waste measurement at a single depot. In this report, we consider the use of available data to formulate management indicators for use at all levels of DoD.

Initial reports indicate that all of the Military Services have reduced their output of hazardous wastes significantly. However, inconsistent data make these reports unreliable, and changes in workload and in the definitions of waste make multiyear analysis difficult.

We recommend the following actions: DoD-wide definition and standardization of data, an effort to quantify the changing regulatory climate, examination of waste reductions by generalized production categories, and movement toward risk-based measurements of progress. Those changes will enhance DoD's efforts to achieve national leadership in environmental affairs.

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